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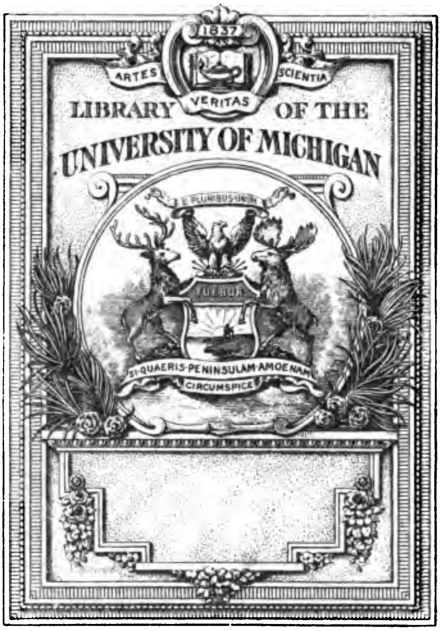

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THE

GLYCERINE BAROMETER.

WITH PLATE

AND

TABLE OF CORRECTIONS FOR TEMPERATURE.

BY

JAMES B. JORDAN

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LONDON:
EDWARD STANFORD, [illegible], CHARING CROSS, S.W.
1881.

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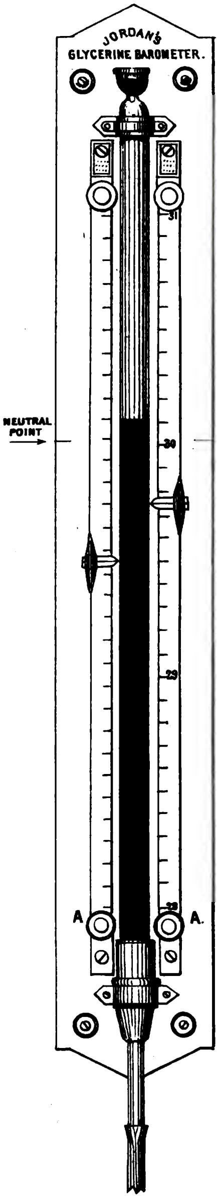
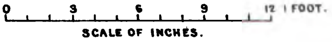
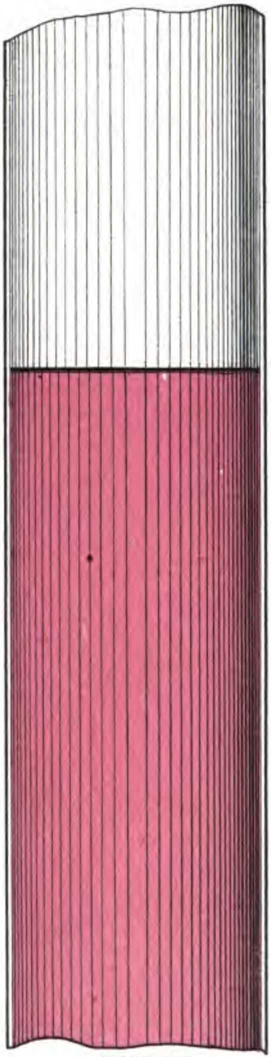
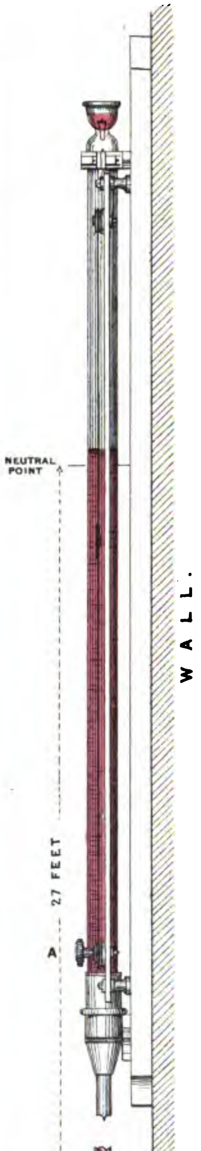
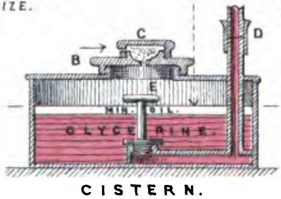






FRONT VIEW
OF PORTION OF TUBE
FULL SIZE.





CISTERN.

JAY B. JORDAN. *delt.*

THE

GLYCERINE BAROMETER.

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WITH PLATE

AND

TABLE OF CORRECTIONS FOR TEMPERATURE.

BY

JAMES B. JORDAN,
MINING RECORD OFFICE, MUSEUM OF PRACTICAL GEOLOGY.

LONDON:
EDWARD STANFORD, 55, CHARING CROSS, S.W.
1881.

JORDAN'S GLYCERINE BAROMETER.

VARIOUS attempts have been made from time to time to construct barometers with fluids of lower density than mercury, with the view of increasing the range of movement of the column by the direct action of the atmosphere, thereby rendering the variations of pressure more distinctly visible, without the intervention of mechanical appliances. It has been thought that if precise instruments of this class were made, they would prove of much scientific value in showing the character of the more minute barometric fluctuations. At meteorological stations, seaports, collieries, and many other important situations, they would render considerable aid to the unpractised eye in detecting frequently and easily the changes which are continually taking place in atmospheric pressure.

Water being the most convenient fluid for a long range barometric column, many water barometers have been constructed, notably that made by Professor Daniell for the Royal Society in 1830. An interesting account of this instrument appears in the Philosophical Transactions for 1832. The

Reclus. MVP. 4-15-38

main tube was of glass, about an inch in diameter and forty feet long, drawn in one length at the works of Messrs. Pellatt and Company; when in position, this tube rested in a closed copper vessel, in which the water was boiled, and forced up the tube until it flowed out at the top, by the pressure of the confined steam. A stop-cock, provided here, was then closed, and the steam pressure being relieved the column fell to its proper level. While the water in the boiler, now constituting the cistern, was still warm, a quantity of pure castor oil was poured on its surface to a depth of half an inch, for the purpose of preventing absorption of air and evaporation of the water. This instrument was at work for a period of two years, but during that time the readings lost greatly in value, partly from the leakage of air into the vacuum and partly from loss of water by evaporation; these defects were caused by the chemical decomposition of the oil used on the surface of the water in the cistern. An elaborate series of observations was made while the instrument was in operation, which showed "that the water barometer preceded by one hour the mercurial barometer of half an inch bore in its indications of the horary oscillations." This was an important fact, but it yet remains to be proved that the same result takes place in the case of the glycerine barometer. On the removal of the Royal Society's rooms from Somerset House, the water barometer was transferred to the Crystal Palace at Sydenham, where it was refilled by the same process. It however soon failed, and the instrument was eventually destroyed by the fire which occurred at the Palace in 1866. In the following year a new water barometer was constructed for the Crystal Palace Company by the author, at the suggestion of Dr. David Price, Director of the Technological Museum; it was made on the same principle as the glycerine barometer herein described, and has since continued in successful operation. A second instrument of like construction was made about the same time for the Museum in Jermyn Street.

Although the water barometer is an instrument of much interest as a weather glass, it is found to be of little value for indicating with certainty the variations of atmospheric pressure, owing to the effect of temperature on the aqueous vapour above the column; this fact led to the examination of other fluids than water for a barometric column, and among those tried glycerine appears to be best suited for the purpose.

Glycerine is a substance composed of carbon, hydrogen, and oxygen, its chemical formula being $C_3H_5(OH)_3$; it occurs in most fixed oils and fats of animal and vegetable origin, and is obtained in large quantities from palm oil and tallow in the process of manufacturing the fatty acids employed by candle makers. It is produced by the action of lime and water on the fats at a high temperature.

The glycerine used for the barometer is a colourless and somewhat viscid fluid, having a specific gravity of 1·26 at a temperature of 60° Fahrenheit.

Although glycerine undergoes decomposition on being heated in atmospheric air, it can be distilled by means of superheated steam and in vacuo. Its vapour has a very low tension at ordinary temperatures, insufficient to influence the height of the barometric column by any appreciable quantity; this property, together with a freezing point far below zero, renders glycerine especially suitable for barometers. The mean coefficient of expansion by heat of glycerine, as determined by Professor Reinold, is ·000303 for every degree of Fahrenheit's scale. From this datum, a table of values has been computed for reducing the observations to 32°. (This table is appended hereto.) As glycerine possesses the property of absorbing moisture on exposure to a damp atmosphere, this action is prevented by protecting its surface in the cistern with a shallow layer of a mineral oil especially suited for the purpose. This oil does not mix with or in any way act on the glycerine, or interfere with the free working of the column, nor does it evaporate at the ordinary temperatures. The mean height of the glycerine column at the sea level is about twenty-seven feet, or above ten times the height of the mercury column.

The present form of the glycerine barometer is one of much simplicity; its construction will be readily understood by reference to the accompanying plate. The tube forming the body of the instrument consists of a piece of ordinary composition gas-pipe, five-eighths of an inch diameter inside, furnished at the top with a gun-metal or brass socket, into which is cemented a glass tube four feet long and one inch diameter inside, the upper end being formed into an open cup shape with a small orifice at the neck, into which is fitted a conical stopper of vulcanized indiarubber. This tube is fixed in position by means of suitable supports provided with indiarubber bearings. In it the fluctuations of the column are observed, the height being read off on carefully divided scale bars placed on either side, and fitted with index pointers, which are moved by means of the milled heads shown at A A in the plate. The scale on the left-hand side is divided into inches and tenths of absolute measure, numbering from the mean level of the liquid in the cistern, while that on the right, divided into tenths and hundredths, shows the equivalent values of a column of mercury at a temperature of 60° Fahrenheit. Each hundredth of this scale equals 0·1076 of an actual inch. The comparative values of the two scales at 60° are as follows:—

Glycerine.	Mercury.	Glycerine.	Mercury.
333·57 inches	= 31 inches.	312·05 inches	= 29 inches.
322·81 „	= 30 „	301·29 „	= 28 „

From this it will be seen that the movements of the glycerine column are 10·76 times greater than those of the mercurial column at the standard temperature. Glycerine being a colourless liquid, the column is rendered more distinct by tinting it red with roseaniline, and a strip of white enamelled glass is placed behind the tube to brighten its appearance.

The fittings above described are attached to a conveniently constructed backboard made of mahogany or oak, fitted with suitable means for securing it on the wall of the apartment or hall where the instrument is intended to be placed. It should be so arranged that the mean height of the top of the column is about five feet above the floor, the main tube being taken down in a direct line to the cistern, which is placed in the basement of the building, either on the ground, or on a suitable bracket attached to the wall, as circumstances may permit. The exact position of the upper part of the barometer is best determined by measuring off on the wall, with a steel tape, a vertical distance of 324 inches, the average height of the column, commencing from the mean level of the liquid in the cistern, the position of the cistern having been previously determined. To this measurement the scales must be carefully adjusted.

The cistern is a cylindrical vessel of copper tinned inside, four inches deep and ten inches in diameter, being one hundred times greater in sectional area than the glass tube, in which the movements of the column take place; this definite proportion of 1 to 100 gives a ready means of making the small correction for capacity when exact readings are required. The top of the cistern is provided with an opening, four inches in diameter, for the convenience of pouring in the liquid and of gaining access to the interior; this opening is fitted with a screwed cover and cap B and C. The air having access through a small hole, indicated by the arrow, is allowed to pass through cotton wool, placed in a recess turned in the cap, for the purpose of filtering out any dust that may be floating in the atmosphere. The projecting tube D, to which the main tube is attached by means of a soldered joint, passes through the top of the cistern, and is connected with a closed channel opening into the centre, below the surface of the liquid; the orifice is fitted with a screw plug E, for use in closing the tube during the process of filling. There is a line drawn around the cistern, two inches above the bottom of it, to indicate where the surface of the liquid should stand when the instrument is in working condition.

The various parts of the barometer having been properly fixed, it is ready for the operation of filling, which is performed in the following manner:—The quantity of glycerine required for each instrument is about one gallon. By heating slightly, it is rendered less viscid, thereby enabling the contained air to disengage itself more freely; the heating may be readily effected by placing the jar containing the glycerine in a vessel of hot water, taking care not to allow any water to get to the inside. A sufficient quantity is then introduced into the cistern to cover the orifice at the bottom, the plug E being securely screwed in its place. The tube may now be completely filled by carefully pouring in the glycerine at the top, and allowing it to flow gently down the side of the tube so as to avoid taking in air. When full, the indiarubber stopper must be inserted, and the plug in the cistern removed for a few seconds, until the column has fallen an inch or two. The instrument should now be allowed to rest until all air in the liquid has ascended into the Torricellian vacuum, and when it is perfectly clear of air bubbles, the stopper must be again withdrawn, the tube filled up as before, and the stopper replaced. Then on finally removing the plug in the cistern, the column gradually falls, free of air bubbles, until it is balanced by the pressure of the atmosphere. The small quantity of glycerine remaining in the cup above the stopper hermetically seals the vacuum and completes the arrangement.

It may be well to remark, in order to avoid any misconception, that it is not pretended that the glycerine barometer can take the place of the standard mercurial barometer as an instrument of precision. All that can be claimed for the new instrument, is the obvious advantage that it possesses of indicating accurately the smallest changes of atmospheric pressure by wide oscillations of a large fluid column, the simplicity of its construction enabling it to be used in situations where it is likely to be of more value to the observer than the ordinary barometer.

Being a comparatively new instrument, it is scarcely possible to decide yet upon its scientific value for recording the character of the more minute variations of aerial pressure; indeed it is difficult to determine its value for this purpose except by the application of an arrangement for self-registration, which it is hoped will soon be adapted, although the nature of the barometer does not readily permit of its association with an automatic apparatus.

It has been remarked that the glycerine column, judging from the viscid nature of the fluid, must naturally be sluggish in its action; but an answer to this objection is furnished by a series of observations made during a period of great atmospheric disturbance, by Mr. Whipple, the Director of the Observatory at Kew, where a glycerine barometer has been placed by a grant from the Royal Society. Comparisons were made at short intervals with the corresponding readings of the standard mercurial barometer, and the differences were noted in thousandths of an inch, the advantage being sometimes in favour of one instrument and sometimes of the other. These small variations were possibly due to the difficulty of securing perfect simultaneity of observation.

There are certain situations in which the glycerine barometer may be peculiarly applicable. It has been observed in our fiery collieries that a sudden depression of the barometric column indicates an atmospheric change which may probably be the first cause of an explosion. The firedamp, which had accumulated in places out of the range of the ventilating system, is set free by the reduced pressure, and thus streams forth into the workings of the colliery, where it forms, with the atmosphere, an explosive mixture. There can be no doubt that in such places the glycerine barometer would prove of much value to those who are responsible for the safety of the workings, for the instrument indicates, far more clearly than the mercurial barometer, all those minute fluctuations in atmospheric pressure which are constantly occurring.

Again, for similar reasons, the glycerine barometer recommends itself for use at meteorological and storm stations, harbours, &c., and at some of our public institutions it has already become an object of popular interest as a weather glass. The subject of the "weather," affecting as it does the health and comfort of every one, is daily becoming of increasing interest. Much has been done of late to stimulate inquiry in this direction by the regular publication in the *Times* of the valuable reports and statistics issued by Mr. R. H. Scott, of the Meteorological Office; and the glycerine barometer having proved itself to be so delicate a "weather glass," one of the instruments has recently been erected in the *Times* Office, and observations are regularly recorded at intervals of two hours, which appear in the daily editions of the paper, in conjunction with the reports alluded to above. An extract from a leading article which appeared in the *Times* of October 29th on the violent storms of the previous days may in conclusion be appropriately introduced. With reference to the glycerine barometer, it was remarked that:—

"By the large increase of scale the variations of atmospheric pressure are rendered palpable in a very striking form. It takes an observer of some practical skill to read a mercurial barometer in tenths, and few persons pay any attention at all to more minute changes, whereas even a mercurial tenth is represented on the glycerine scale by something more than an inch, and therefore becomes visible even to the most unpractised eye. A glance at the records of the present week will show the importance of this increase of scale. During Sunday afternoon even the glycerine barometer exhibited changes of pressure which would only be marked on the mercury scale by hundredths of an inch. The changes became more rapid, however, in the course of Monday morning, and since that time an almost continuous decrease of pressure has reduced the glycerine level from 325·7 inches, where it stood on Sunday at midnight, to 309·6 inches at ten o'clock yesterday morning, at which time it again began to rise. Thus between Sunday night and Thursday morning the glycerine barometer indicated a total fall of more than sixteen inches. Such a record would not be devoid of interest even if it were of little scientific value. It gives a far more palpable measure of what is really meant by a considerable change in atmospheric pressure than can be got by observation of the mercurial scale, and it helps us to realise the vast extent of the changes continually taking place on the surface of the atmospheric ocean at the bottom of which we live.

"A very easy calculation would determine the actual difference of level in the surface of the atmosphere represented by a movement of sixteen inches in the glycerine barometer, and though the same result would be quite as easily deduced from the mercurial scale, it is obvious that the palpable result exhibited by the glycerine strikes the imagination more forcibly and helps the mind to realise more completely what is actually going on in the atmosphere. But far more important than this is the fact that all scientific weather wisdom depends on the barometrical record as its basis, and the increase of scale enables minute changes and diurnal variations to be noted which would escape observation on the mercurial scale. A barometer which almost enables the momentary changes of pressure to be noted by the naked eye cannot but afford material aid in the solution of many of the problems which still baffle meteorologists."

CORRECTION OF OBSERVATIONS.

I. CORRECTION FOR CAPACITY.

Examples.

In the glycerine barometer the ratio of the interior area of the tube to that of the cistern is as 1 : 100.

The neutral point is fixed at 324 inches.

Then if the observed height	=	330	inches.
Neutral point	=	324	"
The difference above N. P. will ..	=	6	"
Then add for capacity	+	0·06	"
And the correct height will be ..	=	330·06	"

In the following example the observed height is below the neutral point:

Observed height	=	320	inches.
Neutral point	=	324	"
Difference below N. P.	=	4	"
Subtract for capacity	−	0·04	"
Correct height	=	319·96	"

II. CORRECTION FOR TEMPERATURE.

The Tables on the following pages give the corrections which are to be applied to the readings of glycerine barometers to reduce the observations made with them to a constant temperature of 32° Fahrenheit.

The values in these Tables have been computed from the following formula:

$$H = h - (0{\cdot}000303 \times (t - 32^\circ)\, h).$$

h = Observed height of column in inches.
t = Temperature in degrees Fahrenheit.
H = Corrected height at 32° Fahrenheit.
0·000303 = Expansion of glycerine for 1° Fahrenheit.

The observed heights are given in the first column for intervals of one inch, and the temperature is shown at the head of the columns in degrees Fahrenheit.

The correction is subtractive in each case.

NOTE.—To reduce glycerine readings to corresponding readings of the mercurial barometer at any temperature, they should be divided by the numbers given in the following table:

Temperature.	Factor.	Temperature.	Factor.
32°	10·70	60°	10·76
40°	10·71	70°	10·78
50°	10·73	80°	10·80

Ins.	32°	33°	34°	35°	36°	37°	38°	39°	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	50°	Ins.
330	0	0·10	0·20	0·30	0·40	0·50	0·60	0·70	0·80	0·90	1·00	1·10	1·20	1·30	1·40	1·50	1·60	1·70	1·80	330
329	0	·10	·20	·30	·40	·50	·60	·70	·80	·89	0·99	1·09	1·19	1·29	1·39	1·49	1·59	1·69	1·79	329
328	0	·09	·19	·29	·39	·49	·59	·69	·79	·89	·99	1·09	1·19	1·29	1·39	1·49	1·59	1·69	1·79	328
327	0	·09	·19	·29	·39	·49	·59	·69	·79	·88	·98	1·08	1·18	1·28	1·38	1·48	1·58	1·68	1·78	327
326	0	·09	·19	·29	·39	·49	·59	·69	·79	·88	·98	1·08	1·18	1·28	1·38	1·48	1·57	1·67	1·77	326
325	0	·09	·19	·29	·39	·48	·58	·68	·78	·88	·98	1·08	1·18	1·27	1·37	1·47	1·57	1·67	1·77	325
324	0	·09	·19	·29	·39	·48	·58	·68	·78	·87	·97	1·07	1·17	1·27	1·37	1·47	1·56	1·66	1·76	324
323	0	·09	·19	·29	·39	·48	·58	·68	·78	·87	·97	1·07	1·17	1·26	1·36	1·46	1·56	1·66	1·76	323
322	0	·09	·19	·29	·39	·48	·58	·68	·78	·87	·97	1·06	1·16	1·26	1·36	1·46	1·55	1·65	1·75	322
321	0	·09	·19	·28	·38	·47	·57	·67	·77	·86	·96	1·06	1·16	1·25	1·35	1·45	1·55	1·65	1·75	321
320	0	·09	·19	·28	·38	·47	·57	·67	·77	·86	·96	1·06	1·15	1·25	1·35	1·45	1·54	1·64	1·74	320
319	0	·09	·19	·28	·38	·47	·57	·67	·77	·86	·96	1·05	1·15	1·25	1·34	1·44	1·54	1·63	1·73	319
318	0	·09	·19	·28	·38	·47	·57	·67	·77	·86	·96	1·05	1·15	1·24	1·34	1·44	1·53	1·63	1·73	318
317	0	·09	·19	·28	·38	·47	·57	·66	·76	·85	·95	1·05	1·14	1·24	1·33	1·43	1·53	1·62	1·72	317
316	0	·09	·19	·28	·38	·47	·57	·66	·76	·85	·95	1·04	1·14	1·24	1·33	1·43	1·52	1·62	1·72	316
315	0	·09	·19	·28	·38	·47	·57	·66	·76	·85	·95	1·04	1·14	1·23	1·33	1·42	1·52	1·61	1·71	315
314	0	·09	·19	·28	·38	·47	·57	·66	·76	·85	·95	1·04	1·14	1·23	1·32	1·42	1·52	1·61	1·71	314
313	0	·09	·19	·28	·38	·47	·57	·66	·76	·85	·94	1·03	1·13	1·23	1·32	1·42	1·51	1·61	1·70	313
312	0	·09	·18	·27	·37	·46	·56	·65	·75	·84	·94	1·03	1·13	1·22	1·32	1·41	1·51	1·60	1·70	312
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307	0	·09	·18	·27	·37	·46	·55	·64	·74	·83	·93	1·02	1·11	1·21	1·30	1·39	1·48	1·57	1·67	307
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302	0	·09	·18	·27	·36	·45	·54	·63	·73	·82	·92	1·01	1·10	1·19	1·28	1·37	1·46	1·55	1·65	302
301	0	·09	·18	·27	·36	·45	·54	·63	·73	·82	·91	1·00	1·09	1·18	1·27	1·36	1·45	1·54	1·64	301
300	0	·09	·18	·27	·36	·45	·54	·63	·73	·82	·91	1·00	1·09	1·18	1·27	1·36	1·45	1·54	1·64	300

Ins.	51°	52°	53°	54°	55°	56°	57°	58°	59°	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	70°	Ins.
330	1·90	2·00	2·10	2·20	2·30	2·40	2·50	2·60	2·70	2·80	2·90	3·00	3·10	3·20	3·30	3·40	3·50	3·60	3·70	3·80	330
329	1·89	1·99	2·09	2·19	2·29	2·39	2·49	2·59	2·69	2·79	2·89	2·99	3·09	3·19	3·29	3·38	3·48	3·58	3·68	3·78	329
328	1·89	1·99	2·09	2·18	2·28	2·38	2·48	2·58	2·68	2·78	2·88	2·98	3·08	3·18	3·28	3·37	3·47	3·57	3·67	3·77	328
327	1·88	1·98	2·08	2·18	2·28	2·38	2·47	2·57	2·67	2·77	2·87	2·97	3·07	3·17	3·27	3·36	3·46	3·56	3·66	3·76	327
326	1·87	1·97	2·07	2·17	2·27	2·37	2·46	2·56	2·66	2·76	2·86	2·96	3·06	3·16	3·25	3·35	3·45	3·55	3·65	3·75	326
325	1·87	1·96	2·06	2·16	2·26	2·36	2·46	2·56	2·65	2·75	2·85	2·95	3·05	3·15	3·24	3·34	3·44	3·53	3·63	3·73	325
324	1·86	1·96	2·06	2·16	2·26	2·36	2·46	2·55	2·65	2·75	2·85	2·95	3·04	3·14	3·23	3·33	3·43	3·52	3·62	3·72	324
323	1·86	1·96	2·05	2·15	2·25	2·35	2·45	2·55	2·64	2·74	2·84	2·94	3·03	3·13	3·22	3·32	3·41	3·51	3·61	3·71	323
322	1·85	1·95	2·05	2·14	2·24	2·34	2·44	2·54	2·64	2·73	2·83	2·93	3·02	3·12	3·21	3·31	3·40	3·50	3·60	3·70	322
321	1·85	1·95	2·04	2·14	2·24	2·34	2·43	2·53	2·63	2·72	2·82	2·92	3·01	3·11	3·20	3·30	3·39	3·49	3·59	3·69	321
320	1·84	1·94	2·03	2·13	2·23	2·33	2·42	2·52	2·62	2·71	2·81	2·91	3·00	3·10	3·19	3·29	3·38	3·48	3·58	3·68	320
319	1·83	1·93	2·02	2·12	2·22	2·32	2·41	2·51	2·61	2·71	2·80	2·90	2·99	3·09	3·18	3·28	3·37	3·47	3·57	3·67	319
318	1·83	1·93	2·02	2·12	2·22	2·31	2·41	2·50	2·60	2·70	2·79	2·89	2·98	3·08	3·17	3·27	3·36	3·46	3·56	3·66	318
317	1·82	1·92	2·01	2·11	2·21	2·30	2·40	2·50	2·59	2·69	2·78	2·88	2·97	3·07	3·16	3·26	3·35	3·45	3·55	3·65	317
316	1·82	1·92	2·00	2·10	2·20	2·29	2·39	2·49	2·58	2·68	2·77	2·87	2·96	3·06	3·15	3·25	3·34	3·44	3·54	3·63	316
315	1·81	1·91	2·00	2·09	2·19	2·29	2·38	2·48	2·57	2·67	2·76	2·86	2·95	3·05	3·14	3·24	3·33	3·43	3·52	3·62	315
314	1·81	1·90	1·99	2·09	2·19	2·28	2·38	2·47	2·57	2·67	2·76	2·85	2·95	3·04	3·14	3·23	3·33	3·42	3·52	3·61	314
313	1·80	1·90	1·99	2·09	2·18	2·28	2·37	2·46	2·56	2·66	2·75	2·85	2·94	3·03	3·13	3·22	3·32	3·41	3·51	3·60	313
312	1·80	1·89	1·98	2·08	2·17	2·27	2·36	2·46	2·56	2·65	2·74	2·84	2·93	3·02	3·12	3·21	3·31	3·40	3·50	3·59	312
311	1·79	1·88	1·98	2·07	2·17	2·26	2·36	2·45	2·55	2·64	2·73	2·83	2·92	3·01	3·11	3·20	3·30	3·39	3·49	3·58	311
310	1·78	1·88	1·97	2·07	2·16	2·25	2·35	2·44	2·54	2·63	2·72	2·82	2·91	3·00	3·10	3·19	3·29	3·38	3·48	3·57	310
309	1·78	1·87	1·96	2·06	2·15	2·25	2·34	2·43	2·53	2·62	2·71	2·81	2·90	2·99	3·09	3·18	3·28	3·37	3·46	3·55	309
308	1·77	1·87	1·96	2·05	2·15	2·24	2·33	2·42	2·52	2·61	2·70	2·80	2·89	2·98	3·08	3·17	3·27	3·36	3·45	3·54	308
307	1·77	1·86	1·95	2·04	2·14	2·23	2·32	2·42	2·51	2·60	2·69	2·79	2·88	2·97	3·07	3·16	3·26	3·35	3·44	3·53	307
306	1·76	1·86	1·95	2·04	2·13	2·22	2·31	2·41	2·50	2·59	2·68	2·78	2·87	2·96	3·06	3·15	3·25	3·34	3·43	3·52	306
305	1·76	1·85	1·94	2·03	2·12	2·21	2·30	2·40	2·49	2·58	2·67	2·77	2·86	2·95	3·05	3·14	3·23	3·32	3·42	3·51	305
304	1·75	1·84	1·93	2·03	2·12	2·21	2·30	2·39	2·49	2·58	2·67	2·76	2·85	2·94	3·04	3·13	3·22	3·31	3·41	3·50	304
303	1·75	1·84	1·93	2·02	2·11	2·20	2·29	2·38	2·48	2·57	2·66	2·75	2·84	2·93	3·03	3·12	3·21	3·30	3·39	3·48	303
302	1·74	1·83	1·92	2·01	2·10	2·19	2·29	2·38	2·47	2·56	2·65	2·74	2·83	2·92	3·02	3·11	3·20	3·29	3·38	3·47	302
301	1·73	1·83	1·92	2·01	2·10	2·19	2·28	2·37	2·46	2·55	2·64	2·73	2·82	2·91	3·01	3·10	3·19	3·28	3·37	3·46	301
300	1·73	1·82	1·91	2·00	2·09	2·18	2·27	2·36	2·45	2·54	2·63	2·72	2·81	2·90	3·00	3·09	3·18	3·27	3·36	3·45	300

Ins.	71°	72°	73°	74°	75°	76°	77°	78°	79°	80°	81°	82°	83°	84°	85°	86°	87°	88°	89°	90°	Ins.
330	3·90	4·00	4·10	4·20	4·30	4·40	4·50	4·60	4·70	4·80	4·90	5·00	5·10	5·20	5·30	5·40	5·50	5·60	5·70	5·80	330
329	3·88	3·98	4·08	4·18	4·28	4·38	4·48	4·58	4·68	4·78	4·88	4·98	5·08	5·18	5·28	5·38	5·48	5·58	5·68	5·78	329
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324	3·82	3·92	4·02	4·11	4·21	4·31	4·41	4·51	4·61	4·71	4·81	4·91	5·00	5·10	5·20	5·30	5·40	5·50	5·60	5·70	324
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319	3·76	3·86	3·96	4·05	4·15	4·25	4·35	4·44	4·54	4·64	4·73	4·83	4·92	5·02	5·12	5·21	5·31	5·41	5·51	5·61	319
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313	3·70	3·79	3·89	3·98	4·07	4·17	4·27	4·36	4·46	4·55	4·64	4·74	4·83	4·93	5·03	5·12	5·22	5·32	5·41	5·51	313
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303	3·58	3·67	3·76	3·85	3·94	4·04	4·13	4·22	4·31	4·40	4·49	4·59	4·68	4·78	4·87	4·96	5·06	5·15	5·23	5·32	303
302	3·56	3·65	3·74	3·84	3·93	4·03	4·12	4·21	4·30	4·39	4·48	4·58	4·67	4·76	4·85	4·94	5·04	5·13	5·21	5·30	302
301	3·55	3·64	3·73	3·82	3·91	4·01	4·10	4·19	4·28	4·37	4·46	4·56	4·65	4·75	4·84	4·93	5·02	5·11	5·20	5·29	301
300	3·54	3·63	3·72	3·81	3·90	4·00	4·09	4·18	4·27	4·36	4·45	4·54	4·64	4·73	4·82	4·91	5·00	5·09	5·18	5·27	300

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